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Explorations in Patagonia

Author(s): Francisco P. Moreno

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The
Geographical Journal.

No. 3. SEPTEMBER, 1899. Vol. XIV.

EXPLORATIONS IN PATAGONIA.*

By Dr. FRANCISCO P. MORENO.

I.

Our President lately recalled the fact that vast areas existed in South America still unknown to geography, which were not only interesting on account of the rich products they may be presumed to contain, but also for the variety, beauty, and charm of their landscapes. This certainly referred, amongst other regions, to certain parts of the Argentine Republic, and particularly to Patagonia.

As a matter of fact, up to quite recent times, the geography of the southern portion of the New World has been in a very backward state. Since the memorable hydrographical expeditions of the *Adventure* and the *Beagle*, supplemented later on by those of the *Nassau* and the *Maine*, we can only remember the Chilian investigations in Chiloe and Guaitecas and on the western coast of Patagonia. With reference to the interior of the latter country south of parallel 40°, the little that was known up to 1870 was derived from Argentine or Chilian surveys of very limited areas, and since the discovery of the Chubut river by the *Beagle* expedition, and the exploration of the river Santa Cruz, in which Charles Darwin took part, the maps of Patagonia have presented no new feature; its fluvial system was taken from the ancient Spanish charts, and of its numerous lakes only some three or four were indicated, and even then their exact position remained undecided.

It was not until 1869-70 that George Chaworth Musters crossed Patagonia from end to end for the first time, in the company of some Tehuelchian Indians, on one of their periodical migrations; but,

* Read in part at the Royal Geographical Society, May 29, 1899. Map, p. 352. A map on a much larger scale will be published in a future number.

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unfortunately, owing to the mode of life he had to follow, and the route chosen by the Indians—the easiest and the one most abounding with game, but still the least interesting one—his narrative, although it constitutes a picture full of life and interest, by the description of the customs of his fellow-travellers and of the general aspect of the landscape, contains little of a concrete or new character from a purely geographical standpoint. It may, therefore, be affirmed that the detailed survey of the Patagonian territory first became of importance when the agitation commenced with respect to the boundary question between the Argentine Republic and Chile.

Both countries claimed, as a heritage from Spain, the austral region, and if both parties were in possession of documents, more or less authentic, which support their arguments as to the respective jurisdictions prior to the emancipation from the mother country over the territory in dispute, little or nothing had been done by them to determine its nature. The Argentine Republic considered as belonging to her the territories to the east of the crest of the Andean mountain range, or the "Cordillera Nevada" of the *conquistadores* and the Spanish historians—a formidable barrier and boundary imposed by nature herself; whilst Chile maintained that her territory included Patagonia as far as the Atlantic coast, and proposed to colonize the territory situated east of the Cordillera, which Captain Simpson, of the Chilian navy, had traversed, in 1873, from side to side, following the course of the Aisen river until he saw it descend from the eastern plains. The Argentine Republic possessed settlements in Rio Negro, Chubut, Santa Cruz, and Staten island; whereas Chile had founded Punta Arenas in the Straits of Magellan, but the interior of the country remained an enigma, which commenced to be solved in 1872, when an Argentine naval officer, Mr. Feilberg, ascended for the second time, forty years after Fitzroy, the river Santa Cruz, and proceeded as far as a lake which he believed to be the one discovered by Viedma, in 1782.

It was in 1873, when I made my first excursion to Patagonia, that I visited the Rio Negro. The year following, I returned to the same places, and went as far as Santa Cruz. In 1875 I crossed from Buenos Aires to Lake Nahuel-Huapi and the Andean Cordillera, between parallels 39° 30′ and 42°. In 1876 I visited Chubut, and ascended the river Santa Cruz, recognizing that the lake found by Feilberg was not the one Viedma discovered, and that these lakes, with many others, formed a vast system situated in a longitudinal depression parallel with the Cordillera. In the tract of land between Santa Cruz and the Straits of Magellan, I was able to confirm the fact already announced by the first Spanish navigators and by the hydrographers of the "Beagle," that the Andean Cordillera was traversed by channels which conveyed the salt waters of the Pacific to the Patagonian plains, and that the chain, shown in many maps as separating Otway Water from the Straits of Magellan,

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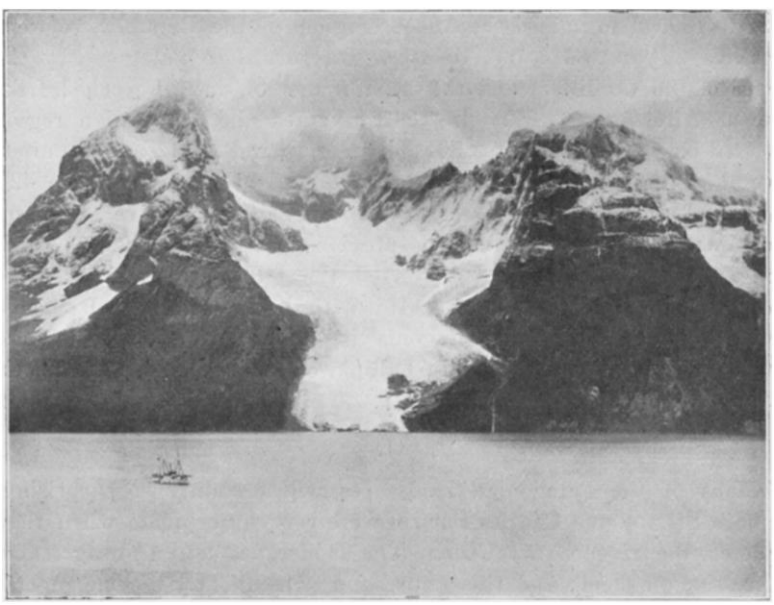
does not exist, the isthmus consisting of an insignificant deposit of loose stones and sand left by the ice, and scarcely raised above sea-level. In 1877, some Chilian officers visited the sources of the river Santa Cruz in the lake. Steinmann shortly afterwards reached the same point, as well as the Argentine travellers, Castillo, Moyano, and Lista. Moyano crossed from Santa Cruz to the Chubut, partly following the route taken by Musters and that of Durnford, who had visited lakes Musters and Colhue in 1877. In 1879 I again returned to the Rio Negro, crossed Patagonia as far as the Cordillera, on parallel 44, and followed the slopes towards the north, again examining lake Nahuel-Huapi, and reaching nearly up to parallel 39°. If, up to that time, the surveying of



EASTERN SLOPE OF THE CORDILLERA OF THE ANDES AT LAST HOPE INLET.

those regions was not exempt from a certain amount of danger, in view of the attitude of the native tribes, this danger disappeared after the defeat inflicted upon them by the Argentine forces. It was at this period that the 1881 treaty was made, by which Argentina and Chile remained separated in Patagonia, to the north of parallel 52°, by the Andean Cordillera; and expeditions continued to explore the latter. The treaty stated that the boundary between the two countries was the Cordillera of the Andes, and that the dividing line was to run along the watershed of the highest crest. But when boundary treaties are not preceded by an adequate survey of the land on which this boundary is to be traced, they always give rise to difficulties when they are being

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actually carried into effect. These difficulties soon arose. Which was the line agreed upon? The Argentines maintained that it was the crest of the Cordillera in its watershed; whereas the Chilians advanced the opinion that the boundary agreed upon was the parting of the continental waters, whether that coincided or not with the crest, or was situated outside, and at a distance from, the Cordillera.

Chile sent out explorers, who penetrated the country from the west; and the Argentine Republic did the same. I myself set to work to carry out similar investigations with the conviction that, in the same way as the logical development of a nation is not achieved unless the geography of its territory be known, nothing can be more prejudicial to its interests than such ignorance in discussions relating to its frontiers. From 1882 to 1895, I examined the Andean regions of the Republic, between parallels 23° and 34°; and, in 1896, I returned to Patagonia by the slopes of the Cordillera and the interior thereof, until I reached Lake Buenos Aires, in 46° 30′. In 1897 I visited the Patagonian region situated between the Straits of Magellan and parallel 51°, and examined several of the western fjords as far as Puerto Montt, in latitude 42°. In 1898 I ascended, for the second time, the Santa Cruz river, reaching the same point visited by me the previous year, on parallel 51°, and, along the eastern slopes, I traversed the territory as far as Lake Nahuel-Huapi and Puerto Montt. It is with this material that I purpose giving a sketch of what Patagonia is, under various aspects; the deficiencies of which sketch will, I think, be made good by the photographs I shall show.

II.

Many of the Patagonian landscapes will certainly be surprising. Captain Fitzroy and Charles Darwin were very unfortunate when they explored the river Santa Cruz. The landscapes left a disagreeable impression on them; and this impression subsequently became general with regard to the whole of Patagonia. In my own country I have found considerable difficulty in obtaining a hearing when I have stated that, although the English explorers spoke the truth, and that any one visiting the same spots would receive the same impression as they did, nevertheless, Patagonia did not merit its bad reputation; but, on the contrary, a vast field for human initiative existed there, with a healthy soil capable of supporting a large population.

In comparing the mountains of South America with those of North America, we might say that the Brazilian mountains have a corresponding situation to the Appalachians; that some of the Peruvian, Bolivian, and Argentine ranges have an analogous position to the Rocky Mountains; whilst the Andean Cordillera corresponds to the ranges on the North Pacific coast. The same vast plains, the same great ridges, and almost the same high plateaus, characterize them. The landscapes

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of the Mississippi are reproduced on the Paraná; the broken plains and the plateaus of New Mexico and Arizona find their analogy in the Argentine northern plateaus and in the table-lands of Patagonia; whilst the ice-bound plains of Canada find modest companions in the extreme south; and the picturesque fjords and white mountains of Alaska seem to be a copy of the fjords and mountains of Patagonia, or *vice versâ*. The analogy might be carried still further. It is surprising what a similarity exists between the ancient industries of the natives of New Mexico and those of north-west Argentina; and any one who compares the ancient customs and industries of the coast of the Pacific Ocean—at either extremity—will obtain some curious revelations.

MYLODON CAVE NEAR LAST HOPE INLET.

The territorial area of Argentina consists of more than a million square miles, and, in three-quarters of its extent, presents the contrast of the most level plains in the world, with mountains which may be reckoned amongst the highest. With the exception of the rugged nature of the north-west regions, which are prolongations of the mountains of Bolivia, and a few small islands of the ancient Pampean sea—so well described by our associate, Colonel George Earl Church—one passes from the superficies of the said sea to the abrupt wall of the mountain in so striking a manner that the natives call the slopes, the "Costa," thus, perhaps, evoking the lost sea or the great lakes which filled it, and of which traces still exist, and which indubitably existed in the human period.

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This spectacle of the mountain abruptly dominating the plain, stops at the height of parallel 34°, and the vast *pampa* is scarcely interrupted at the south by the archaic and paleozoic rocks of the Tandil, the Ventana and the Pampa Central, bounded on the east by the Atlantic, and on the west by the scarcely discernible continuation of the central-northern ridges which divide the plain of a western depression that commences in Bolivia, in lake Titicaca, or further north, and carries the waters of the Eastern Andean region of Argentina to the Atlantic by the river Colorado. This depression is, in its turn, limited on the south by the plateau which separates it from the Rio Negro, and it is this plateau which is generally considered as the northern limit of Patagonia; although, owing to many of its physiographical features, the Patagonian *facies* may be considered as extending as far as the Bolivian plateaus of the Titicaca, agreeing generally with its flora and fauna.

It is difficult to state briefly what ought to be understood by the expression "Patagonian Region" in its general characteristics; and I must, for the present, confine myself to assign its political limits which, on the north, are the Rio Negro; on the south, the Straits of Magellan; and, on the east and west, the ocean. Within its 300,000 square miles, the landscapes offer striking contrasts. To the east, from the sea, are seen coasts with smooth horizontal surfaces, with slight prominences between parallels 44° and 47°, caused by eruptive formations; a coast which is the cliff of the traditional table-land, streaked with grey, yellow and white bands, of dreary aspect, with perpendicular walls, and a scarcity of ports. On the western side, the scenery is utterly different: a number of islands, with abrupt and wooded coasts, fringe the precipitous coast-line of the continent, which is indented by numerous fjords that penetrate to the very heart of the Cordillera and traverse it completely in the 52° of latitude; a coast similar to that of Norway, or, better still, to that of Alaska, with glaciers reaching down to the sea from parallel 44° 30′, and three-quarters of the mountains covered with ice and snow.

Between the two coasts, terraces cut into the elevated plateau, some extensive, others reduced, form the table-lands, separated by depressions (the most extensive, being transversal), generally covered with a layer of pebbles, and, here and there, by lava-streams, between the remains of the ancient range which has nearly disappeared from the centre, which remains are, perhaps, the continuation of the mountains of Central Northern Argentina, and in the west a longitudinal depression that precedes the Andean Cordillera and lies parallel to it. This depression is of a smooth and gently undulating character, of an exclusively erosive and glacial aspect, but evidently of tectonic origin, very beautiful, dotted with numerous lakes. Some of these lakes empty themselves into the monotonous Atlantic rivers; others reach the Pacific in impetuous torrents which cut through the whole mass of the Cordillera. The

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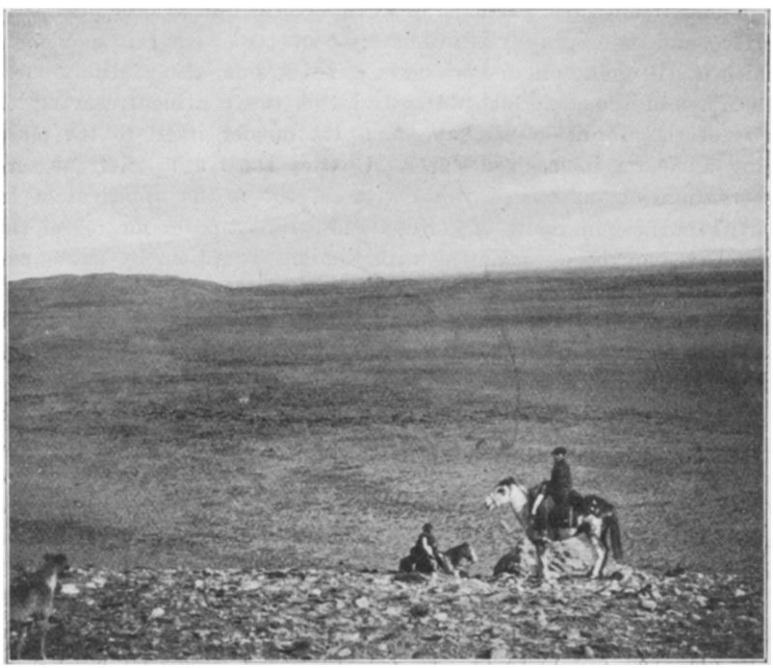
hydrographical network is then so rambling, that it is not always possible to fix the exact course of some of its secondary components, which sometimes flow into the Atlantic rivers, and at other times into those of the Pacific, their course often depending on periods of rain or drought, or the shifting of sand or shingle, and also, sometimes in certain springs, on the action of rodents, which are a veritable calamity in Patagonia, but easy to remedy. This phenomenon of a dividing-line of waters flowing into opposite oceans, which partly rise in plains and glens hardly higher than the level of the sea, and which overcome such formidable obstacles as the Andean Cordillera, piercing its crystalline axis and the



CONTINENTAL DIVIDE IN THE GLACIAL DEPOSITS OF RIVER VISCACHAS.

enormous mass of rocks which have accumulated upon this axis, constitutes, in my opinion, a fact which is unique in the world.

It is very possible that, when a careful survey of the Andean Cordillera and its vicinity is made, it will be proved that a great portion of its actual upheaval took place in very modern epochs; and that man, already possessing a culture analogous, to a certain extent, to that of nations which are reputed civilized, witnessed the modification of the physiognomy of the soil of South America. It seems to me incredible that man could have found means of existence at an altitude of 18,000 feet, and yet, at this elevation, on the Puna de Atacama,

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human remains have been found, which proves that he did. The gigantic ruins of the Bolivian table-lands suggest that the upheaval of the soil to its present altitude was subsequent to the construction of the buildings, the ruins of which are preserved, as man could not now construct similar works there. I have seen on the Puna de Atacama, in parallel 26°, at an altitude of 14,000 feet, the remains of extensive villages, where it would not now be possible for moderate groups of people to live. It is well known that there are abundant remains of the great pampean mammalia in the clay formations of the Bolivian plateaus; and it is difficult to believe that such animals could have lived at that altitude.

The extreme south participates in this recent upheaval of the Earth's surface, and its orography is intimately connected with this movement, which is still going on, and which is, with erosion, also probably one of the causes of the abnormal water-divide of the continent leaving the crest of the Cordillera in Patagonia, to transfer itself to the plains lying alone on its eastern slopes. Charles Darwin has left us some observations of the utmost value with respect to the upheaval of the Earth's surface in South America; and it is a matter for regret that they have not been continued with similar attention by subsequent observers.

If a careful examination be made of the accounts given by the early navigators who visited the extreme south of America, we shall find that the country, as they saw it, has been modified in several places. It is very possible that some remains of the channel shown in some of the maps, between Admiralty sound and San Sebastian bay, in Tierra del Fuego, existed at that period; that the isthmus which separates Otway Water from Magellan straits, did not then rise above high-water mark; and that several of the streams now flowing into the Pacific from the east of the Cordillera, and even from the Patagonian plains, crossed them to reach the Atlantic:—a mass of facts which ought to attract militant investigators, all the more that the places in which they are to be observed are, more or less, easy of access, compared with other places in the world, of less interest, but which, nevertheless, are much better known.

In the reports of Dr. Otto Nordenskjöld, the Society possesses a general exact picture of the physiognomy of the large island of Tierra del Fuego. This island I have only seen from the sea; and Sir Martin Conway has graphically described the mountainous western portion. My description will commence, then, in the Straits of Magellan. When the coast is observed from the Atlantic, one sees the straight line of the terraces on both sides, and the others of Virgin Cape. Once in the straits to the north, on the low base formed by the coast, the tertiary line stands out, now receding, now advancing; its regular summits broken by small hills, which are so many extinct volcanoes. At the foot of the

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plateaus, gorges and low hillocks fill up the ancient extension of sea waters, which, not very long ago, dashed at the foot of the plateau, but now are far away. To the south, in Tierra del Fuego, the same dreary views exist, but minus the volcanoes, the effects of which are only seen, in a very limited area, near the straits; and so one reaches the west, until, to the north, the principal table-land is seen rising towards the west and penetrating towards the north-west, forming a vast circle, which is lost in the distance, snow-capped mountains rising on the horizon. To the south, the grand Fuegian island terminates, after leaving the narrows; and the northern beach continues along the vast sheet of the straits.

The Patagonian tertiary formation ceases there, and with it its characteristic aspect. Steamers anchor in Punta Arenas, in the ancient island, now the Brunswick peninsula. From there, in clear weather, can be seen, to the south, the snow-capped summits of Mounts Sarmiento, Darwin, and Olivaia, in the high ranges which are the continuation of the Chilian Cordillera of the Coast and the Cordillera of the Andes, which are lost to view in Staten island and Cape Horn. Any one who follows the navigation of the straits will not fail to perceive the curious topography of the region and its varying outlines. It has the appearance of recently inundated land, from which the waters are receding after having covered it entirely. More than once, in crossing Patagonia, I have recalled to my mind the appearance of Magellan straits when I found myself in the transversal depressions which cross the country, and I have imagined a cluster of more or less extensive islands, of a general elevation analogous, and of similar type, to that formed, at no very distant date, by Magellan straits and what we might call the Straits of Gallegos.

The islands of this archipelago, formed by upheavals and submergences, connected with the tectonic movements which have formed the present Andean cordillera, and to which movements must be ascribed the fractures which give the austral region such a characteristic aspect, were separated from one another by straits similar to Magellan, which straits disappeared with the general upheaval and the glacial deposits, leaving more or less extensive valleys through which flow the rivers Negro, Chubut, Santa Cruz, Coile, and Gallegos and its affluents, and others having no permanent fluvial currents. It has been said that the interior of Patagonia is formed by a succession of terraces, having an east-to-west direction up to the Cordillera; this does not appear to me to be altogether exact, but it is indubitable that at one time the whole region rose uniformly to a greater height in the west than along the present Atlantic coast. The Saint Gregory cliffs in the straits, in their western part, are more or less of the same elevation as those of the confluence of the Rio Negro and the Limay, in parallel 39°; the same topographical features distinguish these cliffs near the mountains;

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and we might assert, even, that their strata are of the same age, as is proved by the fossils which have been found in them. The recent volcanic eruptions extend from parallel 41° up to the straits in the same zone; and the periods of eruption seem to have been almost indentical; the Mount Aymond volcanoes are similar to those of Mount Yagagtu in Rio Negro territory. The uniformity is almost general: the same geology, the same fauna, and the same flora; and it only alters in the north with the remains of the longitudinal ridges which appear to the south of Rio Negro with its granites, porphyries, trachytes, and ancient schists, extending, in more or less imposing masses, as far as the river of port Desire, dividing Patagonia and its table-lands into two parts, north of this parallel. I am of opinion that, in the early days of the tertiary formation, Patagonia was of greater extent than at present; that a part of its territory advanced much further into the Atlantic; and that the bed of the latter, between the present coast-line and the eastern parts of the Falkland islands, was nothing else than a plateau, submerged at a relatively modern epoch, the upheaval of which has again commenced.

The bold, characteristic relief of the Patagonian terraces is intimately connected with the upheavals, and erosions produced by great rivers and lakes, the greater part of which have since disappeared. These terraces are really true lines of level left by these rivers and lakes, which did not all, however, have their origin in the present Cordillera; but some had their origin in the centre of the country, which to-day is almost entirely waterless, and which, it also appears to me, were connected with lands which have now disappeared.

The larger number of the lakes which fed these rivers in the Andean region still exists; but of those of the central region scarcely any remain; the twin lakes Musters and Colhue are rapidly drying up, together with a few insignificant lagoons. Nevertheless, when the territory is crossed, one sees great cavities—empty lakes—and vestiges of their powerful outflows. Their shores present characteristic terraced levels; and in connecting their lines of elevation, one finds that, as I have remarked, the terracing is not generally regular. The present terraces are nothing but the evidences which have been left by ancient lacustrine or fluvial levels; and although the altitude above the sea of the strata of which the general table-land is composed is greater on the west—thus exposing to view others on the western border of the plateau which do not appear in the Atlantic coast—this fact is not of a perfectly absolute uniformity, as, in San Julian on the sea-coast, cretaceous strata are observed, as also in the vicinity of the Cordillera.

The monotonous plateaus generally terminate, as I have stated, in the vicinity of the first mountains, which are parallel with the true Cordillera, and the general character of the Patagonian region completely changes. If you examine the map of South America, you will

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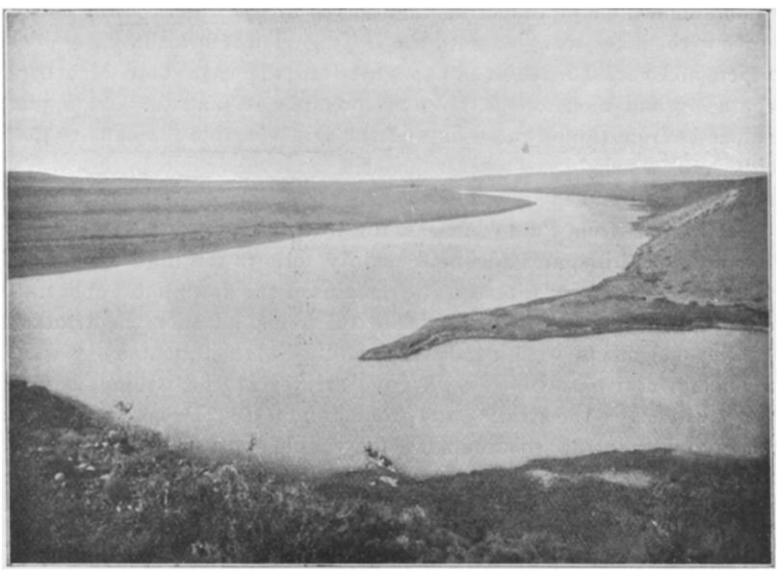
see that, to the south, two chains of mountains exist: the Cordillera of the Andes, and the Cordillera of the coast in Chile. It may be said that, from the Atacama desert, the two chains run parallel to each other; at times their spurs seem to become confounded; but the geologists Pissis and Domeiko have pointed out an intermediary valley running between them, throughout their extension, from north to south. In the north, this valley is filled principally by the products of recent volcanoes; it is then contracted, and almost obliterated, by the spurs referred to; but it subsequently widens out to form the very fertile central valley of Chile, gradually descending to the south until it buries itself beneath the Pacific, opening out or contracting itself, as in the



RIVER SANTA CRUZ.

north, and covered with alluvial deposits and ashes even under the coast waters of the Pacific, as far as Tierra del Fuego; a tectonic valley, and perhaps one of the longest in the world. Parallel to this, but situated to the east of the Cordillera, a similar valley is found, the existence of which was suggested by me in 1879, which is more or less continuously contracted or effaced by the same causes, but not completely buried under water, as has happened to the western valley. The Andean Cordillera rises between the two depressions. The Chilian valley penetrates the sea at parallel 42°; but three degrees above, the chief part of its extension, it is occupied by a series of lakes, generally transversal, which seem to fill cavities that coincide with profound ravines in the Cordillera, whereas the Argentine valley only

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sinks beneath the sea 10° further south. In this eastern longitudinal valley, the actual lacustrine series fills the space comprised between parallels 38° and 52°, at times interrupted by local tectonic accidents, which took place after its period of formation, or by vulcanism or accumulations of glacial detritus. This general valley forms one of the most interesting, most fertile, and most beautiful zones of South America, owing to the variety of its topographical forms, the geological construction of the enclosing mountains—which breaks the monotonous grey of the Alpine views—the flora with which it is adorned, and the immense glaciers, some of which send crystalline icebergs into the green or blue waters of the lakes. Another Patagonian contrast is the white and blue ice on the black basalts, crenellated peaks, and cliffs of monumental shape reflecting themselves in the waters of the western shores of the lakes, mingled with the leafy garlands formed by the woods, so rich and varied in their flora; whilst to the east, bare of arboreal vegetation and monotonous, rises the precipitous plateau. At a jump, one passes from the elevated flats of the arid volcanic plateaus to green fields and wooded valleys; from stiff and miserable bushes to the handsome fern and fuchsia region.

Setting out from Punta Arenas, towards the north, the woods cover the cretaceous hills, and the road mainly follows the high-water mark, winding between rocks, the erratic remains of the now almost obliterated moraines, and partly traverses beautiful fields. Under the trunks of old trees one meets with deposits of molluscs, the remains of meals of the ancient natives. In this way one arrives at the isthmus between Otway water and the straits; the ground undulates, the woods disappear, and, gradually, erratic boulders become visible everywhere, looking like small isolated hillocks between the cretaceous hills and the distant cliffs of the Saint Gregory plateau and the straits, where salt lakes—vestiges of the very modern upheaval of the region—are to be seen. Immediately to the west is Otway Water; and at the bottom the low hills of King William's land, which precede the "Cordillera Nevada."

The Andine eastern longitudinal depression is partly represented there by the Fitzroy channel, and its vicinity is dominated by the edge of the western tertiary plateau, which rises gradually, cut out on the western shores and ravines by rain and frost; and, to the east, the volcanoes Orejas de Burro, Mount Aymond, and La Picana, from 700 to 1000 feet altitude. I have already remarked that the plateau commands the straits from Virgin cape. Between this and the valley of the river Gallegos, the undulating surface is grassy, sparse in timber, with deep gorges which cross each other, and with volcanic cones which have scattered lava-streams in ancient and recent times. Hundreds of thousands of sheep now pasture upon it, whilst in the deep gorges of the Atlantic coast, gold-seekers continue their researches in the glacial deposits. The Argentine-Chilian frontier line crosses it from

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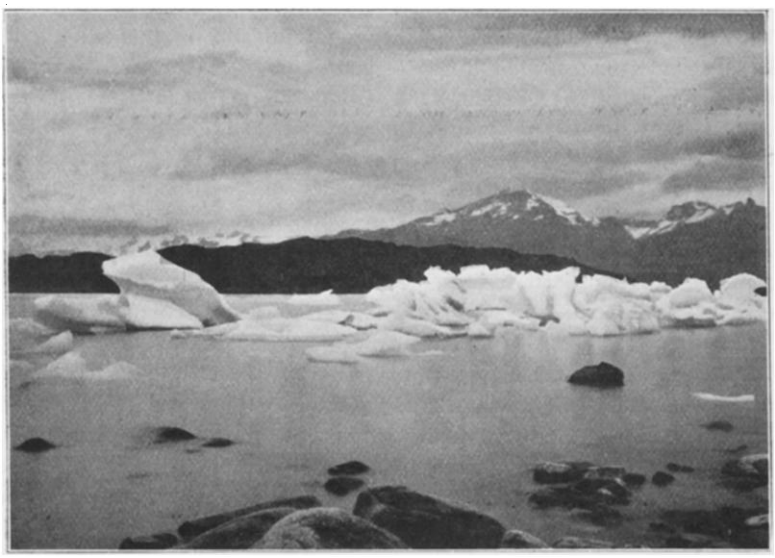
east to west, up to Mount Aymond, deviating from that point up to the intersection of meridian 70° from Greenwich with parallel 52°, at the base of the Picana crater, to follow the parallel to the coast of the western channels. These volcanoes appear as though they did not extend to the west of the longitudinal depression, as I have not seen there, amongst the rocks moved down by the ice, any pieces of lava. An arenaceous conglomerate, covered with erratic boulders of granite and quartzite, separates another glacial depression filled by the Blanca lagoon, which is now gradually disappearing, divided into two sections, the northern limit being the edge of the plateau which continues to the Campana hill, which forms its western extremity. The surface of this



WESTERN ARM OF LAKE ARGENTINO.

is always undulating pasture land, and shows, on the west, small groves of *Fagus pumilio*. To the north and east flow affluents of the river Gallegos, and to the west, rounded hills, dotted with erratic boulders, rise above the plateau.

The northern edge of the table-land overlooks another transverse valley of the continent, an ancient strait, as I have said before, in which the river Gallegos now runs, and at its base several andesitic hills are encountered, which rise up above the valley in the vicinity of the two edges of the plateau, but without attaining the altitude of the latter. The broad valley which extends between Obstruction sound and the Atlantic ocean, an ancient channel filled with glacial detritus, which gives it a characteristic appearance, with extensive lateral

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moraines and frontings cut by the great glacial river, the gradual decline of which is shown by the terraces left by its distinct levels.

When the Spanish navigator, Ladrillero, in 1557, entered the channels to the west of the Cordillera, in search of a passage to the Atlantic, he found low-lying lands, and in them a channel more than 45 miles long by 4½ wide, penetrating east-north-east. In 1830 Lieutenant Skyring and Mate Kirke, of the *Beagle*, explored the same regions, and observed a vast expanse of water divided by a low isthmus cut by a river which drained it, the remains of the Ladrillero channel. I say "remains," as I think that the elevation of this isthmus is of very recent date, as indicated by the young trees referred to by Kirke. This sheet of water is now known by the name of Lake Balmaceda; and to the south of this another one of the same size, Lake Pinto, is found, whilst to the east there are other smaller ones, situated between various lines of moraines, more or less destroyed, which separate the waters that, from the northern and southern plateau, flow westward to feed these waters, and, eastward, to form the river Gallegos. This is a characteristic glacial landscape; the boulder clay, which is seen very distinctly in the Blanca lagoon, fills the valley, being displayed in large patches in the same way as is observed in all the other northern valleys. The remains of dividing moraines does not attain in some parts an altitude of 200 feet above sea-level, and abounds in large erratic, perfectly striated rocks.

This river and its affluents flow in a capricious and winding manner, leaving on either side the marshy remains of the ancient fresh-water channel. Imagine the British Channel dry, covered with boulder clay deposits, and a river wandering in its centre to the east, receiving streams from the cliffs of the two coasts, while little hillocks, like those in some parts of London, separate the western streams from little lakes overflowing in that direction to the Atlantic, and you will have the impression of every one of the transverse depressions of Patagonia, the western Atlantic being replaced there by the Pacific channels or the Andean lakes. Lake Balmaceda measures, approximately, 40 square miles, and is partly fed by the waters of other smaller lakes and by streams. Between the most eastern of these lakes and a group of smaller ones which send their waters to the river Gallegos, there is a glacial deposit barely 60 feet wide. In times of flood, these small lakes communicate with each other, and for the time confound the waters flowing to the Pacific with those which go to the Atlantic. It also seems that one of the affluent rivulets of Lake Balmaceda is thrown off from the river Rubens, an affluent of the Gallegos. This river and its affluents have a winding channel, leaving lagoons on either side, the remains of the ancient channel now replaced by the valley.

The present transverse valley takes part in the longitudinal depression

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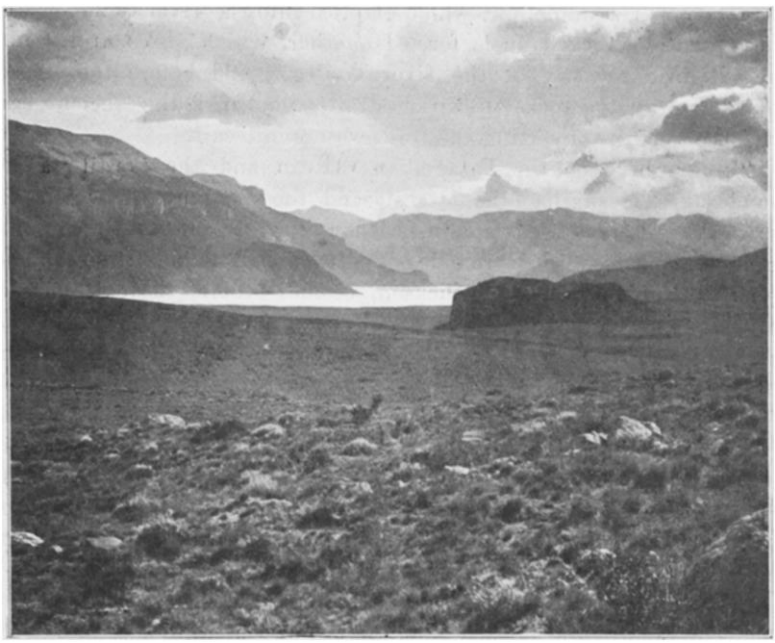
now occupied by the waters of the Pacific, and is bounded on the south by the plateau extending between the Gallegos river and Magellan strait, and on the north by what has been called the Latorre Cordillera, which is not a mountain range, but the continuation of the general table-land itself. Between this and the channels, rise, south of the parallel 52°, the cretaceous ridges, Rotunda and Palladium hills, and to the west, the mountains in front of the principal chain of the Cordillera, here formed by the Sarmiento Cordillera. In Last Hope inlet, which forms a part of these channels, the eastern longitudinal



ANCIENT EASTERN OUTLET OF THE LAKE SAN MARTIN.

valley depression, to which I have referred, terminates under the sea-water.

Dr. Otto Nordenskjöld has given the Society a general description of the part of this depression comprised between the Sierra de los Baguales and the Last Hope inlet, and I will only dwell on this in order to amplify these *data* with a few new observations which complete them. If one penetrates to the extreme west of the Last Hope inlet, this is seen to open out into three branches; the centre one gives entrance to a small lake situated in an opening, which it seems had previously communicated with the Canal de las Montañas, in the extreme north of which flows a river draining another lake, likewise situated in the same depression. The Canal de las Montañas constitutes

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the extreme end of a longitudinal valley which separates there the central chain of the Andean Cordillera from the more fragmentary lateral ridges, and to which Mount Balmaceda belongs, and at the eastern base of which the river Serrano empties, bringing to the inlet the waters of the eastern general depression from Mount Stokes glacier, which feeds Lake Dickson. The same river also receives the waters of the central chain, at the base of which is Lake Tyndall, which is bounded on the west by a sheet of ice, truly *Inlandeis*, the remains of that which, in other times, covered the region as far as the present Atlantic coast. All the lakes of the region, even the eastern lagoons, are remains of a single lake which emptied into the river Coile; whilst the present Pacific channels formed another, which also emptied into the Atlantic by way of the river Gallegos, and before the erosion wearing away the rocks in Kirke straits connected the ancient lake with the Pacific, converting the fresh waters into salt.

To-day, between the Patagonian plateau and the Cordillera are found lakes Maravilla (the largest, and the moraines of which are perfectly preserved), Sarmiento (without visible outlet—which must be subterranean—also surrounded by moraines), Paine, Hauthal and Tyndall, Nordenskjöld and Dickson, besides others, the existence of which is known, but which have not been closely inspected. These lakes, formed in tectonic fractures and continued in depressions cut out by the ice, are separated from each other by isolated mountains, of more or less altitude, some having extensive glaciers, as in the case of the interesting Mount Paine, a beautiful massive tertiary granitic laccolithe capped with cretaceous slates, connected by a transversal ridge with the main chain of the Cordillera, and not a volcano as Dr. Nordenskjöld thought; others formed of the same slates, of less height, and with rounder peaks, presenting the form of a whale-back—the name one of them bears—all being mountains which formed the islands of the great exhausted lake, the bed of which, to a great extent, has disappeared, either through the upheaval of the soil or through the glacial detritus which covers all the shores. The landscape is extremely picturesque in this region. To the west, the high mountains of the granitic central chain, with its ice-field and its *nunatacks;* lower down, wooded valleys and the mountain-lakes between the fjords studded with icebergs detached from the ice-fields. Then come the wooded mountains, some with glaciers, of the lateral ridge, formed by metamorphic schists, probably of the lower cretaceous, cut by the deep lakes and by the rivers which drain them. Next we have glacial lakes, occupying the old mouth of the lost fjords, and surrounded with moraines on the east; and, on the north and south cretaceous mountains covered with woods, and hills polished by the lost glacier of the first extension of the glacial period. Then follow the tops of the little transition hills, of the upper cretaceous, which precede the tertiary table-land, and which it may be said limits

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the longitudinal depression. The western slates, greatly contorted, assume fantastic forms with their folds, through the deposits of snow between the layers, and rise perpendicularly above the fjords. In one of these intermediary hills, near Last Hope inlet, is situated the cave where the piece of *mylodon* skin was found which has so much attracted the attention of English naturalists. The explanation of the presence there of this extremely interesting piece is difficult; at a time when the animal died, probably the cave was not situated at the same altitude as it is to-day, and the proof of this is the perforation of the rock by pholades. The discovery made by the geologist, Mr. Hauthal, one of my travelling companions, of a bank of *Mytilus edulis*, situated about 7 feet above sea-level, is an evident proof that the upheaval continues.

As I have already said, the transition is violent between the Cordillera and the Patagonian plain; it is most notable in this part of the depression. To the west from the high raised cliff, called Sierra Dorotea, and inclined in the same direction, the tertiary sandstone appears, which extends from the Straits of Magellan, always cut by the transversal depressions, which, further north, surround the base of the Sierras Baguales and Viscachas. This sandstone, in its turn, is covered by the neo-volcanic tuffs, and the glacial gravel deposits which form the so-called Latorre Cordillera, and which, as I have said, is only the characteristic Patagonian plateau, gradually rising from the Atlantic towards the Cordillera, to which, perhaps, at one time, it was united. I have visited the depression and the plateau, and in my excursions I have crossed all the transversal depressions, and have always found the same physiographical character. The tertiary sediments rise gradually from the Atlantic towards the Cordillera; in the vicinity of the latter cretaceous formations appear with tertiary eruptive rocks, the upper ones under the tertiary, the lower exposed at the surface in the centre of the depression, bordering the chains of the Cordillera composed of gneiss, granite, and quartzite, and some sandstones of undetermined age. On the table-land there are more or less extensive patches of volcanic eruptions with their tuffs; the part played by these eruptions in the upheaval of the soil it is not yet possible to determine conclusively, but they have taken place during the whole of the tertiary period up to recent times.

Between the Sierra Dorotea and Punta Alta rises the principal affluent of the Gallegos river, which waters the whole valley, and is occupied by important *estancias*, as is also the case in the neighbourhood of Lakes Maravilla, Sarmiento, and Paine. I have crossed the Patagonian plateau in the vicinity of the Atlantic, and also between Punta Arenas and the Sierra de los Baguales, and, *de visu*, I can state that, although, looking at the cliff from Obstruction sound, it may be considered as a mountain ridge, it has not the slightest analogy with the general idea of a mountain. Its surface, generally flat, with small

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undulations produced by glacial erosion, more numerous on the west, covered with gravel, and displaying erratic boulders of great size, extends towards the east, losing itself in the horizon, abounding with guanacos and ostriches, poor in trees and pastures, forming another ancient island between the transversal depressions of the Gallegos and Coile rivers, which also carried to the Atlantic, in other days, the waters of that part of the Cordillera in their broad channel. To-day the enormous accumulation of glacial detritus has modified the hydrographic regimen. At the extremity of the north-west cliff of the plateau rises the principal arm of the river Coile and also the Guillermo rivulet, which flows westward to empty in Lake Maravilla, forming, in this way, another instance of the water-parting of the continent in the plain, on the east of the Cordillera. The landscape is essentially glacial; the various semicircles of the moraines and the winding ridges are seen with perfect clearness, and have accumulated such a quantity of remains, that it must be admitted that the glaciers which produced these accidents had no great oscillations before retiring to where they are now seen in the Cordillera. Large erratic boulders abound as far as 50 miles east of the present snowy mountains; and on the shore of the Coile, near the so-called Mount Palique, a tertiary hillock, covered by the remains of a moraine, I have seen some granitic rocks measuring as much as 400 cubic yards. This so-called Palique mountain is washed on the east by the Viscachas rivulet, one of the most interesting streams of the region, and similar in its characteristics to the river Fenix, to which I shall refer.

The transversal shores of the Sarmiento-Coile's ancient channel is bounded on the north by the Baguales mountains and Viscachas plateau. These mountains were formed by a general upheaval, greater to the west of the plateau, their relief having been increased by modern eruptions, and on the west by cretaceous rocks, among which Hauthal saw layers of diorite, which have accentuated by their upheaval the relief of the mountains. They appear to be separated from the Cordillera by the continuation of the longitudinal depression, which is contracted in that part, and filled with ice from the mass to which Mount Stokes belongs. This glacier separates the basins of the southern lakes from that of Lake Argentine, which feeds the river Santa Cruz, thus sending waters to the Atlantic and waters to the Pacific, by the eastern side of the Cordillera. These waters flow southward to Lake Maravilla by three main streams — the rivers Zamora, Baguales, and Viscachas. The latter, which is the most eastern, and rises in the basaltic plateau, has a course particularly worthy of notice: first it flows to the south-east; then it inclines further east, to again twist violently to the west to the foot of the Palique hill. I have examined these points, and found there one of the most interesting cases of river-capture of Patagonia. In March, 1898, a ledge of shingle and sand, scarcely

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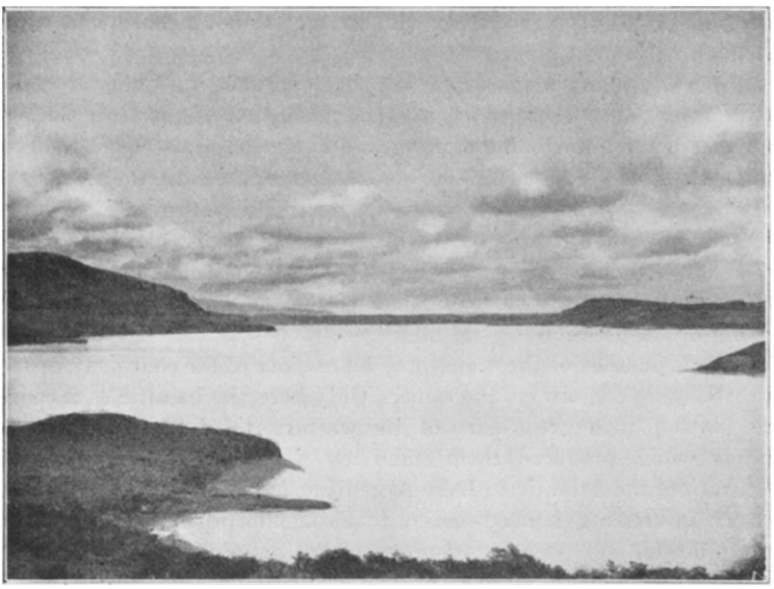
3 feet in height, divided the river Viscachas from other channels, then dry, which in the rainy season flowed to the Atlantic; and the natives of the place assured me that at certain periods, when it was in flood after the melting of the snows, the waters flow indiscriminately towards both sides. To-day the waters are diminishing on the east of Patagonia; for some years past rains have been less frequent, and this diminution explains certain phenomena produced there in their distribution.

The Gallegos-Coile plateau turns to the east, diminishing in elevation, eroded by glacial action into cavities, having fresh and salt water ponds or pools, the remaining vestiges left by the Atlantic at the time of the last upheavel of the table-land, until it contracts to the transverse



ANCIENT EASTERN OUTLET OF LAKE BELGRANO.

valley through which the principal affluent of the Coile river runs. If this is crossed and traversed to the north, ascending and descending the undulations covered with glacial mud and with great erratic blocks, and a grassy country which will soon pasture thousands of sheep, one penetrates into the broken ground of the east of Sierra Viscachas between lava-streams of the most picturesque aspect. This is one of the points of Patagonia where the layer of glacial gravel which covers it is most visible. It is seen that, in certain places, the horizontal character of its layers has undergone modifications, and I have examined places in which the gravel layers may be said to be almost vertical, which is only explicable by very recent subsidence or faults. I crossed the plateau from the middle of the Santa Cruz valley to the west, and took the opportunity

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to examine its terraces and the isolated depressions of ancient levels, and I think I am safe in asserting, supported by observations made at other points, that some of the depressions of the plateau, and therefore some of the elevations of its borders, are caused by local subsidences, such as occurred in the Yagnagoo plain in the territory of Rio Negro. The St. Joseph bay and New Bay, on the east coast, must have the same origin. Some low hills which are seen on the plateau are entirely composed of beds of stratified rounded gravel, and appear to be the remains of a general layer which has now almost disappeared.

As always happens in Patagonia, the region is more broken to the west than to the east of the plateau; deep gorges, more or less wide, contain rivulets, the remains of the rivers which in former times fed the great Coile drainage system, which river has not a continuous course all the year round.

From the open plateau (2500 feet) one overlooks the extensive valley of the river Santa Cruz, which is deeper than that of the river Gallegos and that of the Coile, being more stony and sterile. I ascended the river Santa Cruz in 1877 and 1898, and I can appreciate the labours of Fitzroy and Darwin when they tried unsuccessfully, to reach its sources. Undoubtedly the great river will be easily navigable by steamers when its channel is once known, its current not being extraordinary, seeing that it was always overcome with a small 9-knot steam-launch during my last ascent.

This is another of the transverse depressions of the continent, opened in tertiary layers, always the same. Only here the basaltic lavas cover the plateau in a great part of its western third, and upon it the craters which produced them stand out. The tertiary cliffs of this valley, from the Atlantic to Lake Argentino, have furnished the remains of very interesting fauna peculiar to Patagonia, upon which I cannot now enlarge.

The valley of the Santa Cruz has also been occupied by ice, and is covered with its detritus. To the east of Lake Argentino, where it rises, one sees on the cliff which overlooks the present river, 150 feet above it, erratic boulders of 600 cubic yards, which have been left by the glacier that formerly covered the lake, the moraines of which limit it.

Lake Argentino is more extensive than Lake Maravilla, partaking of the tectonic and glacial lakes. It extends 60 miles to the west; and the fjords of its extreme west divide into three arms, which receive the waters of large glaciers from Mount Stokes up to the vicinity of Lake Viedma. An important river flows into the end of the north fjord, with clear waters—a sure sign that it proceeds from another great lake still unknown. The western end is closed by the main chain of the Cordillera with its glaciers, which cross to the Pacific fjords of Peel inlet and St. Andrew's sound, and one can distinguish peaks

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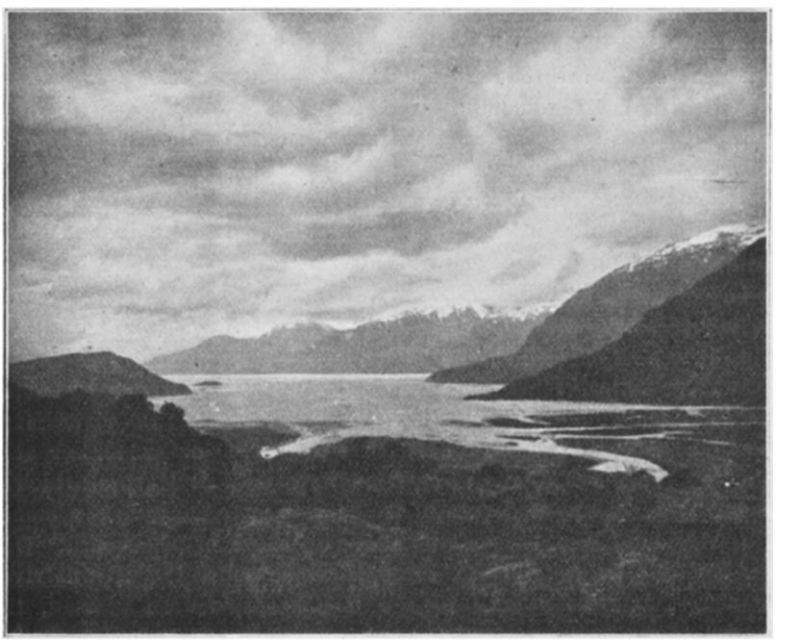
more than 10,000 feet, as Mount Agassiz (10,597 feet). The lacustrine fjords correspond to the western channels, and communicate with those of the south by the glacier of Mount Stokes by Lake Dickson. Undoubtedly Lake Argentino was more extensive formerly. Mount Buenos Aires and Mount Frias were, in very recent times, islands in the southern part of the lake. To-day the waters are rapidly retiring; a large expanse of the southern shore, which was under water when I saw it in 1877, was dry in 1898. The lands left by the retiring waters are very fertile, and the last time I visited the spot several thousand head of cattle were grazing, having been brought there by two



MOUTH OF THE RIVER LAS HERAS, IN THE CALEN INLET.

English cattle-raisers. This is the first herd that has been raised in such distant regions.

The river Leona drains into the eastern extremity of Lake Argentino, to which it carries the waters of Lake Viedma. This river has a stronger current than the Santa Cruz, between upper cretaceous cliffs, crowned by fossiliferous tertiary caps, which are also observable at the south of the former lake, in which abundant saurian remains have been found. The cretaceous marine formation is observed to the west, at the base of Hobler Hill and Castle Hill, mountains named by Fitzroy, who saw them in the distance. I ascended Leona river in the same steam-launch which had been up the Santa Cruz, and I believe that this river would be easily

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navigable when once it had been surveyed. The cliffs, completely denuded in the vicinity of Lake Viedma, are composed of clays, sands, and volcanic tuffs, contain numerous tertiary mammal remains, which await the collector. The gravel cap which covers them did not seem to me so thick as it is further south, and perhaps may have been swept away more easily, as the ravines are at first more frequently produced, perhaps, by neighbouring volcanic eruptions.

Lake Viedma (828 feet) is larger than Lake Argentino, and of a more regular shape in the points examined by my assistants, although it would not be surprising if it had fjords similar to the latter. A vast glacier reaches to the water, and, in clear weather, I have seen it descending from the west like an immense ice-field, from the crest of the central chain, 10,000 feet high, which the ice covers up to its western slope in Eyre sound. To the south and north of this other narrower glaciers are seen in the extremity of the fjord-like bays.

This lake also occupies a tectonic depression, which stretched to the Atlantic, and has had a much greater extension than Lake Argentino, which it still exceeds in extent. At its eastern extremity an extensive ancient arm is seen, which continues up to the narrower valley of the Shehuen river, which empties into the Chico river before it reaches the bay of Santa Cruz. Various dry streams, which were the affluents of this river, were probably the last remains of the northern drainage before it was all effected by the Leona river—a similar instance to that of the river Coile. When I visited this lake in 1877, there were some lagoons which were dry in 1898. The plateau between the river Santa Cruz and the Coile is more broken than that south of the former, and, following the north of the river, one climbs up this plateau, which is covered with basalt, underneath which appear cretaceous sandstones with horizontal folds — a continuation of those of the south. One then descends by depressions through which runs the present river Shehuen, that rises at the base of the same western plateau, the pedestal of the Pana volcano. Again climbing an isolated portion of the plateau, one descends into the true valley of the Shehuen, another depression corresponding to Lake San Martin, which is nothing but the fjord of a large ancient lake. When, in 1877, I followed this valley to descend to the lake, the stream, dry to-day, was partly filled with water. When it has any water now, through snow melting on the lateral plateaus, it runs eastward a little way; but it now seems that it does not reach the river Shehuen, the greater part going westward to the Tar lagoon, which empties into Lake San Martin—another phenomenon of capture, perhaps more interesting than that of the Viscachas, which changes the water-parting of a continent. The Tar lagoon is a remnant of the ancient extension of Lake San Martin, which goes on disappearing, and is found in a plain between the moraines left by the old glacier. Judging by Viedma's account, at the close of the last century a drainage-basin

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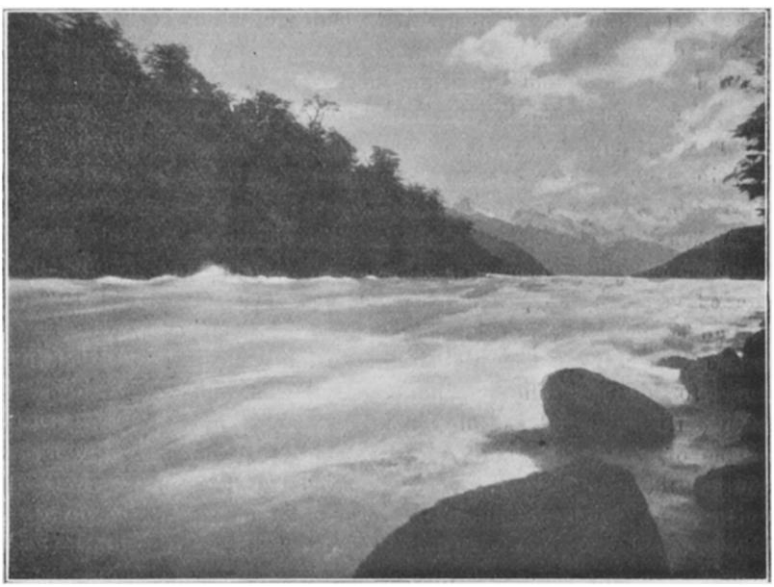
existed to the east, as the natives stated that the Shehuen (or Chalia) river proceeded from a lake. The Kochait mountain—a porphyry boss, the layers which covered it having completely disappeared—gives a picturesque aspect to the scene, which is varied to the west, monotonous to the east. Through beautiful fields, the bed of ancient lagoons, like Tar, dry to-day, surrounded by moraines, and then through a succession of lines of these,—one arrives at Lake San Martin, the eastern part of which is much smaller than that of Lakes Viedma and Argentino, but the fjords thereof seem to be longer. On the south and east it is enclosed by glaciers between high mountains, but on the north it was impossible to reach its end, owing to the storms which overtook us during the ex-



RAPID IN THE RIVER LAS HERAS.

pedition, which also prevented our examining another arm situated on the east of the principal longitudinal depression. It drains into the Pacific by a river flowing from the end of the southern arm. This river is 150 yards wide, and, after crossing a little lake and forming small waterfalls, runs in a northern direction to Calen inlet, thus forming the river Toro, which flows into the south-eastern arm of the inlet. The great river which the Argentine boat *Golondrina* examined in 1897, and which empties in Eyre sound, descending by a longitudinal depression between the mountains of the central chain, seems to come from a yet unsurveyed lake.

The lake is very picturesque. Its slopes, polished by the ice, partly covered with *Fagus* and *Drimys* woods, and quantities of

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Libocedrus of considerable size are seen, and can be profitably exploited when these regions are inhabited, which will be soon, in view of the interest of the Argentine Government in it. Its altitude above the sea is 690 feet, and soundings of 1000 feet have not reached the bottom. When I made my last journey, I followed towards the north, climbing the plateau covered with basaltic lava, and in which craters are very frequent. To the west the lava-streams hide the cretaceous caps, but characteristic fossils are found in its slopes. The centre is a vast lava-field, relatively flat, traversed by streams which generally issue from small lakes, and which empty to the south into an extensive lake enclosed by lava-streams, without any known outlet, called Lake Cardiel, but the ancient channel of which to Rio Chico still exists. Another stream empties to the north into Lake Quiroga, which occupies another volcanic depression of the tableland, also without present outlet, and north of that lake another larger one has its outlet to the river Chico. According to the natives, great salt lakes exist on this plateau. The Andine longitudinal depression continues always to the west, formed here, in part, by the eastern fjord of Lake San Martin. The neo-volcanic lava-streams have formed a ridge between the river Fosiles, which flows into Lake San Martin, and the river Carbon, which flows northwards as an affluent of the Mayer river. The cretaceous rock is denuded in the steep gorges; and more or less important coal-seams are seen in them.

The river Mayer constitutes another instance of the continental water-parting to the east of the Cordillera. Its eastern affluents and the waters forming the river Chico of Santa Cruz, rise in a depression, the remains of an ancient lake, of which two small lagoons are left as vestiges; the outlet thereof on the east is still visible, as are also the distinct levels left by its retiring waters, after stationary periods. I have followed the river until I saw it, voluminous and torrential, enter the first mountain of the Cordillera, but it was impossible for me to see whether it empties into the northern arm of Lake San Martin or runs straight to the west of the central chain towards some of the fjords, visited by the *Golondrina;* but recently it has been explored by my assistants, who discovered that the river empties into the lake San Martin.

The upper basin of the river Mayer is found at a much greater altitude than that of the lakes already named; the interior longitudinal Andine depression must be found more to the west, so that the plateau between the San Martin and it corresponds to a similar topographical type to the Baguales and Vischacas Sierras. The river Chico rises in the plateau near Lake Quiroga, between the lava-streams, at 4070 feet, and bends eastward when it has once reached by a deep ravine an ancient lake, now dry, where, in the same plain, it increases its waters and sends others to the west by an affluent of the river Mayer. The bed of this lake is situated at 1640 feet, and occupied by two small

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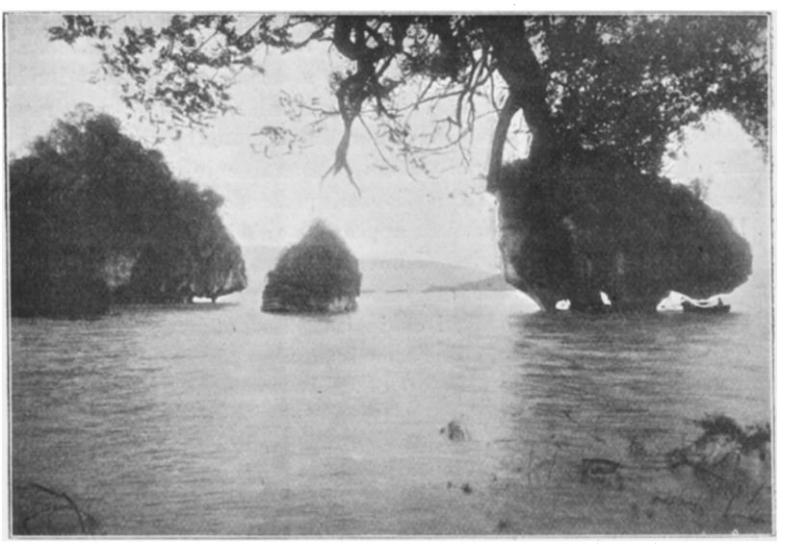
lagoons, the former communication of which towards the east is perfectly distinct. A little more to the north of the point at which the waters of this basin unite with those from the small glaciers of the adjacent mountains, to form the river Mayer, discovered by Mr. Hatcher in 1897, there falls into it a torrent from the north (1300 feet) which brings it the waters of a series of lakes situated between a ridge which dominates on the west the basin referred to, and which continues to the north up to Lake Belgrano, cut by Lake Burmeister (2740 feet); this lake, in its turn, drains through the Robles stream into the river Belgrano, affluent of the river Chico. The ridge corresponds to that which extends from Lake San Martin between Fosiles river



MARBLE ISLANDS AT THE LAKE BUENOS AIRES.

and the eastern fjord of the same lake. Perhaps the depression where Lakes Nansen and Azara are found corresponds with that fjord. These lakes receive the waters of the beautiful Belgrano lake, which, in its turn, receives those of Lake Volcan, which is close to it. Lake Belgrano, situated at the base of the eastern ridge, emptied, in modern times, to the east, towards the Atlantic, and had a greater extension than is observed in the series of magnificent terraces which are seen in this direction overlooking the river Belgrano, which winds in the valley, to unite with the river Chico. The Tehuelches Indians, when Viedma made his voyage to the lake that bears his name, told him that the Rio Chico flowed from a lake in the Cordillera. Was this lake the Belgrano, or the smaller Lake Bermeister (2740 feet)? I cannot say now. The wide valley of the Rio Chico, the immense quantity of glacial

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detritus it contains, and the presence of great erratic boulders, weighing some dozens of tons, which I have seen at its mouth in the bay of Santa Cruz, demonstrate, without leaving any room for doubt, the existence of a great lake in the latter part of the glacial period, of which the present Lakes Volcan, Belgrano, Nansen, and Azara formed a part, which said lake diminished as soon as communication to the south was opened with the present river Mayer. Lake Volcan is situated at 2560 feet, the Belgrano 2495 feet, and the Azara 2395 feet. The latter enters, on the west, a mountain with glaciers, and drains through a violent stream into Lake Nansen (2296 feet), the western arm of which turns more to the west than the others to the main chain, from the glaciers of which it obtains its waters. Here one observes that the mountains diminish in height towards the south, and are probably cut lower down by the waters of the river Mayer, to which the waters of Lake Nansen arrive through a series of rapids. During the examination I made in 1897 in Calen inlet, I found two rivers which drained into the eastern extremities of its two channels, but neither of them had a flow of waters comparable to what I had seen in the river Mayer. Besides, the Rio Coligue, according to a companion, Mr. Lange, who partly ascended it, appears to rise in the mountains, and does not cross the main chain. I have not found in this river Coligue, any pebbles of neovolcanic origin which correspond to the formations on the east of the central chain composed of granite, porphyry, and quartzite; nevertheless, I saw some huemules (*Cervus chilensis*), which indicates the existence of a pass low down between the east and west of the Cordillera, or else a river which traverses it in the vicinity.

The Indians inhabiting the Pacific channels south of Calen inlet hunt the huemul in some valleys at the end of the numerous fjords, which is a proof that low gaps were to be found in the main chain of that part of the Cordillera, or that rivers intersected it.

The huemul is only found to the west of the Cordillera when river-beds or low passes exist, and it is an error to consider it as peculiar to the Chilian fauna. It principally exists in the western intermediary zone, between the table-land and the first rocky hills, it having even been found in the hills in the vicinity of Port Desire on the Atlantic coast.

If one follows the course of the river Belgrano towards the north, one leaves to the east the Patagonian plateau with its raised borders covered with basaltic lavas, and which attains its greatest height in the Mount Belgrano (6560 feet). Short streams rise at the foot of this eminence, and lose themselves in the lagoons between the lavas or in the centre of the country, such as the Olnie, which becomes extinct in an ancient lake-depression some distance to the west of the main road used by the natives in the very lowest part, where a temporary lagoon still exists. The small gap which separates the waters of the Belgrano on the west from the edge of the raised plateau measures 4920 feet, and, crossing to

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the other side, there is another stream descending rapidly towards the north to a lacustrine depression, which, starting in a north-north-west direction, then twists to the west. This depression is the deepest that can be found in Patagonia north of the Lake Maravilla, and is principally occupied by Lake Pueyrredon. The eastern part of the plateau north of Mount Belgrano rapidly decreases in height, and the continental water-parting is situated a good distance to the east. The saline lake, nearly dry to-day, which exists there has an altitude of only 345 feet above sea-level, and is the remains of an ancient, more extensive lake; for Lake Posadas, separated from the said lagoon by a glacial drift, measures 400 feet, whilst Lake Pueyrredon, into which it flows, is scarcely 295 feet above sea-level. I have crossed the region some tens of miles to the east, and my attention was directed to the deep and extensive depression in which runs the intermittent stream, called Gio, and it would not be surprising if it corresponded to a very inferior level, and that this may be less than 330 feet above the sea. Unfortunately, when I was there I had not sufficient time to observe them. It cannot be said to-day whither the cavity of the saline lake extends, descending towards the centre of the valley, connecting itself with the actual depression of the river Gio; but, undoubtedly, it forms a part of the same transversal depression which stretches to the Atlantic to the south of Port Desire, and similar to those already mentioned. The southern cliff of the plateau falls almost vertically about 1600 feet down to the depression, whilst on the north it gently rises up to an isolated porphyritic mountain, which is visible from a long distance — Mount Colorado (4600 feet), at the base of which lies the Gio lagoon (1000 feet), fed by an important stream which runs from the west, and then, after descending, from the north, and rising at an altitude of 4625 feet.

The waters of Lake Gio lose themselves in the vicinity of its outlet and in the low plain which extends to the east, and to the east of the saline lake are other smaller lagoons and pools, whose waters do not reach the plain where it is crossed by the general road to the north. Lake Pueyrredon, an ancient tributary of the Atlantic, now empties itself into the river Las Heras by the west, after receiving the waters of Lake Brown, situated slightly more to the west of its centre. A little to the south of Lake Brown a river rises which flows west, and receives its waters from glaciers which also give rise to the river Lacteo, an affluent of Lake Belgrano, and to the west of Lake Brown there are other lakes still unsurveyed.

My assistants, overtaken by the snow, could not reach last year the end of Lake Pueyrredon, nor see, consequently, its outlet; but I have just received news from them, telling me that it empties by a short river into the river Las Heras, an important torrential river, as great or even more voluminous than the river Palena, situated more to the north. During my examination of Calen inlet, I discovered in the north-eastern

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arm a river of great volume and depth, descending from the north, but with such a strong current that it was impossible to row against it, and undoubtedly this river is the outlet of the network of lakes situated to the north of Lake Belgrano, and to the east of the main chain of the Cordillera. I do not think this drainage is effected by any unknown river which may empty into one of the bays—Boca de Canales, Jesuit inlet, or Kelly bay. Another important river falls into the northern arm of the Calen inlet, and an enormous glacier is seen there which extends a great distance in this direction; whilst from the west, fed by great glaciers of the eastern slope of the main chain of the Cordillera, an affluent reaches the great river Las Heras, which is the outlet of Lakes Buenos Aires, Soler, the river Tamango, Lake Pueyrredon, etc. The river Tamango has its source in the immediate vicinities of that of the principal affluent of Lake Gio, and flows to the river Las Heras through another transverse depression, towards the west, a short distance north of Lake Pueyrredon.

The gorge of the affluent of the Gio, passing an opening in the plateau (4625 metres), continues towards the north by that of the river Jeinemeni, which, after receiving an affluent rising in a small lake at 2395 feet, empties into Lake Buenos Aires, the largest in Patagonia. Almost parallel with this river runs the one called De los Antiguos, owing to the native remains which are found there, and which correspond to races which no longer live in Patagonia, as I have ascertained after examination of some of their remains. The region between Rio Gio and Lake Buenos Aires is the most dreary that I know in Patagonia, and also the most sterile; it is covered with large lava-deposits from craters which are scattered over the fragmentary elevated plateau. The affluents of the river Desire, which I have crossed, have their sources there. There is nothing more desolate than this landscape, despite the vivid colouring imparted by the tertiary caps burnt by lava, rich in vertebrate remains, and overthrown from their primitive position by the subsidences which a central longitudinal depression has produced, and which follows the route bordered on the east and west by high plateaux capped with basalt. The contrast between the landscape at the foot of pre-Andine mountains and that of the main road across the table-land is worthy of remark. To the west, bubbling, crystalline streams run between the rocks and the forest, making the passage difficult,—the swamps and the abrupt mountains; to the east, a despairing monotony, always the black basalt line, the small bushes and shrubs—when there are any—and the glittering of broken pieces of obsidian which the gravel frequently contains; bare white and yellow cliffs, black wall, or white beds of dried-up lagoons, and here and there a large erratic boulder where the guanaco is hunted. The sole distraction for the traveller in those uninhabited regions are the ostriches and the guanacos. The Olnie rivulet waters the ancient district of the Tehuelches—"Olnie

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aiken" = "where there is grease," a favourite hunting-ground, the reputation of which has been handed down by tradition. The natives say that there was much more water there previously; that one of its largest lagoons, dry to-day, was always filled; and that they could camp in any part of the wide lost valley, which is not the case to-day.

This route, between Lake Belgrano and Lake Buenos Aires, is interesting because it demonstrates the ancient distribution of waters in Patagonia and their subsidence. The same number of terraces can generally be counted from the main surface of the plateau: five important ones 165 feet in height more or less; and four varying from 65 feet to 20 feet, as though the causes which brought about the disappearance of the great lost lakes and rivers had been produced contemporaneously. Likewise this part, better than any other, confirms the opinion, already generally accepted, that Patagonia was covered by an extensive ice-cap, at least as far as the present coasts. The great granitic and quartziferous erratic boulders which proceed from the main chain of the Cordillera prove this, and when once the ice disappeared, the climatic conditions permitted the permanent existence of great rivers and lakes which eroded the surface, which was gradually uplifted. It is indubitable that a great portion of the lavas which are seen on the plateau to-day were deposited prior to the glacial period, but it is also certain that the eruptions have continued up to relatively very recent times, as, in some points, not the slightest vestige of erosion can be noticed on its surface, whilst at others it is polished and striated by the ice.

(*To be continued.*)

ROAD-MAKING AND SURVEYING IN BRITISH EAST AFRICA.*

By Captain G. E. SMITH, R.E.

On May 6, 1895, I received orders to proceed forthwith to Zanzibar, to assist the late Captain B. L. Sclater, R.E., in the completion of a road from Mombasa to the shores of the Victoria Nyanza, in order to improve the communications between Uganda and the coast. It was to be a continuation of the "Mackinnon road," which had previously been made by Mr. Wilson under the Imperial British East Africa Company as far as Kibwezi, a distance of 180 miles from Mombasa, and was to be of the simplest kind, unmetalled, and, in fact, the roughest track along which a bullock-cart would go. Captain Sclater, who had previously had two years' experience of rough road-making in Nyasaland (British Central Africa), remained in England to collect the necessary stores for the expedition, while I went out in advance to organize the caravan.

On June 2, 1895, I reached Zanzibar, where I found more than usual

* Read at the Royal Geographical Society, June 26, 1899. Map, p. 352.

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